Investigation of Ground Water
Conditions and Percolation
Procedures in the Upper Santa
Clara Valley

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in the
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REPORT

to

SANTA CLARA VALLEY WATER CONSERVATION DISTRICT
San Jose, California

on

INVESTIGATION OF GROUND WATER CONDITIONS
and
PERCOLATION PROCEDURES
in the
UPPER SANTA CLARA VALLEY

by

WOODWARD-CLYDE-SHERARD & ASSOCIATES
Consulting Civil Engineers
Oakland, California

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January 25, 1960

Job No. 3389

Mr. J. Robert Roll, Chief Engineer
Santa Clara Valley
Water Conservation District
15420 Almaden Road
San Jose, California

Dear Sir:

In accordance with your request, we have completed an investigation of ground water conditions and percolation procedures in the Upper Santa Clara Valley, Santa Clara County, California.

Our investigation indicates that the high ground water conditions in the vicinity of Bailey Avenue can be alleviated by suspending percolation in the lower portion of Coyote Creek while increasing the capacity of percolation facilities in the area of the Lower Gorge.

The accompanying report includes details of data utilized in the study and recommendations based on our findings.

Mr. A. R. McBirney, Staff Geologist of our firm was assigned to this project.

Very truly yours,

WOODWARD-CLYDE-SHERARD & ASSOCIATES

By John A. Trantina
John A. Trantina
Engineering Geologist

Reviewed By Richard J. Woodward
Richard J. Woodward, R.E. 8229

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REPORT

to

SANTA CLARA VALLEY WATER CONSERVATION DISTRICT

on

INVESTIGATION OF GROUND WATER CONDITIONS

and

PERCOLATION PROCEDURES

in the

UPPER SANTA CLARA VALLEY

INTRODUCTION

For many years, the ground water levels in certain areas near Spreckles' Hill and Bailey Avenue in the Upper Santa Clara Valley have been very near the surface. Agricultural use of the land accordingly has been handicapped by saturation or even flooding of fields. Although these conditions have varied somewhat as a result of wet and dry climatic cycles, records extending back to 1900 show that the problem has persisted since at least that time and probably longer.

As a result of earlier investigations, summarized in our report of November 17, 1959, it was found that although numerous factors are responsible for the high water levels, percolation through permeable gravel layers in Coyote Creek may contribute to the saturated conditions.

PURPOSE AND SCOPE

This report summarizes an investigation of the feasibility of modifying percolation methods on Coyote Creek. It has been proposed that the high ground water condition in the vicinity of Bailey Avenue be alleviated by suspending percolation. This would be done in the lower portion of Coyote Creek between the Riverside Golf Course entrance and the Lower Gorge whenever the level of water in Well No. 8 ("Reiter Well") is less than 5 ft below the ground surface.

Possible consequences of such a procedure have been considered with reference to water levels in three sections of the Santa Clara Valley:

1) Between Anderson Reservoir and Bailey Avenue,
2) Between Bailey Avenue and the Lower Gorge,
3) Below the Lower Gorge.

Data reviewed in the course of the study included records of investigations carried out by the Bay Cities Water Company between the years 1902 and 1905, and by the Santa Clara Valley Water Conservation District from 1936 to the present. With the great amount of information available from these two sources, little additional field data was required and field work was confined to measuring water levels in the upper section of the valley and examining pertinent facilities for transmission and percolation of water in the area of the investigation.

GROUND WATER CONDITIONS

Under present conditions, water released from Anderson Reservoir normally flows through the entire length of Coyote Creek for a distance of approximately ten miles to percolation ponds, just below Lower Gorge, (Fig. 1) In this interval varying quantities of water enter permeable gravels in the stream channel and contribute to the ground water of Santa Clara Valley.

The entire volume of water moving down the valley, both in the form of surface flow in Coyote Creek and as subsurface flow through permeable strata, must pass through the constriction of the gorge before entering the Lower Santa Clara Valley. Various estimates of the average annual flow range between 25 and 35 CFS, but peak flows in Coyote Creek frequently exceed these values by a wide margin.

The ground water profile of the Upper Santa Clara Valley, as shown in Fig. 2, has a nearly uniform gradient of approximately 12 ft per mile above the uppermost influence of the gorge. Since this gradient is considerably less than that of the ground surface, which averages approximately 17.5 ft per mile, the depth of the water table decreases from 80 to 85 ft at the upper end of the valley to less than a foot just above the gorge. The gradient flattens to approximately 8 ft per mile before entering the gorge, then steepens abruptly to about 15 ft per mile through the constriction.

Since the cross sectional area of the ground water body in the gorge is much smaller than that of the upper valley, the gorge in effect functions as a weir, and the gradient variations in this section result from the increased head that is required for the higher velocities necessary to maintain a flow equivalent to that in wider sections of the valley.

In order to attain the necessary gradient increase through the gorge the ground water level rises at the upper entrance and causes a flattening of the gradient for some distance upstream. The decrease in velocity upstream resulting from lowering the gradient is balanced by an increase in the cross sectional area of the ground water body, and in order to predict the water levels and gradient for various conditions, several additional factors, such as the shape of the aquifer and its permeability, must be known. Fortunately, tests have been conducted to establish the nature of ground water profile under a range of conditions and theoretical calculations are unnecessary.

PERCOLATION IN COYOTE CREEK

An analysis of numberous tests conducted since 1957 reveals that percolation rates in Coyote Creek are highly variable and are controlled by a combination of several factors. A plot of percolation rates against measured flows in corresponding sections of the creek (Fig. 3-A) shows no simple relationship. Similarly, no apparent correlation could be found between percolation and ground water levels (Fig. 3-B). Bank storage and seepage, together with a lack of equilibrium produced by rapid variations of flow, may have considerable influence on apparent percolation rates, especially during winter months.

In general, however, the pattern of these measurements shows that certain sections of Coyote Creek have consistently high percolation rates, while in others, reduced percolation or even return flow may occur. Typical percolation rates are shown on Fig. 2. It is readily apparent that little or no percolation is obtained in those sections between Daly's Crossing and the Golf Course Crossing and between Malech's Crossing and Metcalf Road. An average of 11 percolation checks tabulated in Table 1 shows that about 53.1% of the total percolation occurs in the upper half of the channel above Daly's Crossing while in the lower half an average rate of only 3.53 CFS or 33.9% has been obtained. It is doubtful whether the maximum percolation in the lower half of the channel ever exceeds 10.0 CFS for sustained periods. This rate would be attainable only under optimum conditions and with very large flows.

Thus the efficiency of percolation in Coyote Creek decreases in its lower half, and the quantities of water percolated in the upper section are approximately twice those obtained between Daly's Crossing and Lockyear's Crossing. Between Daly's and the Golf Course Crossings and between Malech's and Lockyear's Crossings, Coyote Creek frequently becomes an effluent stream. At some point between Lockyear's Crossing and Metcalf Road, where the increasing ground water gradient permits piezometric levels to drop below the surface, effective percolation again becomes possible.

Between September 13 and October 12, 1959, a test was conducted to determine the effect of percolation in the lower part of Coyote Creek on water levels in the vicinity of Bailey Avenue. During this period the flow in Coyote Creek was reduced to approximately 15 CFS at the diversion with all of this flow being absorbed before reaching the PCA ponds. Water levels in Wells 8 and 145-A and Test Holes 4B, 4C and 7A, recorded by continuous hydrographs (see Fig. 4) show several significant features.

Water levels in all five holes showed a remarkably sensitive response to precipitation and percolation in the lower part of Coyote Creek. Although somewhat overshadowed by the marked effect of heavy rains on September 18, water levels began to decline steadily approximately one week after percolation was suspended. Following a lag of about 9 days the water level began to rise sharply on resumption of percolation. The rate of fall and total depression in

Test Hole 7A west of Spreckles" Hill, was significantly less than in wells closer to Coyote Creek. Well 6, which penetrates the upper alluvium and enters more permeable gravels below showed a greater response than test holes entirely in the alluvium.

The total apparent depression in Well 6 was 1.5 ft to an elevation of 246.20 ft, approximately 2.3 ft below the ground surface. It is not known how much further the water level would have been depressed had the test been extended over a longer period.

EFFECTS OF PERCOLATION AT THE LOWER GORGE ON BAILEY AVENUE WELLS

During the summer months percolation is conducted in the Coyote Ponds at and below the Lower Gorge. The rate of percolation is variable but averages approximately 30 acre-ft per day or 15 CFS. This water is added to the subsurface flow just below the gorge and results in a rise of the ground water level in that area. This, in turn, has an effect on water levels at and immediately above the gorge. In order to maintain a constant gradient and flow through the gorge the upstream level is also elevated somewhat and the downward break in gradient at the constriction is moved downstream from its normal position.

The effect of raising the water level at the gorge is limited to a relatively short interval and can safely be assumed not to extend as far as Bailey Avenue as long as ground water levels in the valley are not much lower than

5 ft below the surface. (At lower levels the effect of percolation near the gorge will extend farther upstream.) Since the gradient in the open valley is not influenced by changes downstream, increased percolation at the gorge will have no effect other than an upstream shifting of the intersection of the open valley gradient with the flatter gradient immediately above the constriction.

This fact was well demonstrated in tests conducted during 1939 by the SCVWCD. By observing water levels along a section between the gorge and Bailey Avenue when percolation was interrupted and later resumed, it was shown that the upstream limit of the percolating pond effect lies somewhere between Well 140 (about 3000 ft above Metcalf Avenue) and Malech's Crossing, depending on the position of the normal ground water level in the valley.

The expected effect of increasing percolation in the vicinity of the gorge is schematically illustrated in Fig. 5. Within reasonable limits a rise of water levels immediately above Metcalf Road would move the intersection of the two gradients upstream from A to B. This should not influence any measures taken above point B to lower the ground water level at Well 8.

If percolation is suspended in the lower portion of Coyote Creek, water levels in wells situated between the upper limit of effect of the Coyote Ponds and Bailey Avenue will be lowered by an amount approximately equal to that in

Well 8, and additional percolation in the vicinity of the gorge would in no way interfere with efforts to lower the water table to Bailey Avenue.

EFFECT OF LOWERING WATER LEVEL AT BAILEY AVENUE ON UPPER VALLEY

Lowering of the water level in Well 8 to an elevation 5 ft below the surface will also have an effect on wells between Bailey Avenue and Anderson Reservoir. Although the exact nature of this effect cannot be predicted it is possible to state the limiting range that can be expected.

Assuming percolation is maintained at the present rate in the upper portion of Coyote Creek between Daly's Crossing and the diversion while it is suspended in the lower portion of Coyote Creek, the normal consequence would be a steepening of the ground water surface in the upper half of the valley. This results from the fact that while the quantity of water flowing down the upper section remains unchanged, the lowering of the water level below Daly's Crossing decreases the cross sectional area of the ground water body, and requires a slightly steeper gradient and velocity to transmit an equal flow.

Such a steepened gradient, if projected upstream from the proposed water elevation in Well 8, would intersect wells at depths which will be 5 ft or less below their present levels. The maximum depression will occur at the lower end of this section while wells closer to the diversion will show relatively minor effects.

A persistent warping of the ground water surface has been observed in the section between Bailey and Palm Avenues. A slightly steeper gradient is found in this interval in nearly all water surface profiles dating from 1904 to the present. It is not unlikely that this represents a section of decreased permeability, such as a clay layer, or a reduced cross section due to an irregularity of the bedrock surface. The effect of such a constriction would be to reduce the upstream effect of a lower level at Well 8, and water levels above that point would show even less effect than predicted above.

POSSIBLE EFFECT BELOW THE LOWER GORGE

Although the average quantities of water effectively percolated between Daly's Crossing and Metcalf Road are small (less than 3 CFS), the importance of this contribution to the ground water in the Lower Santa Clara Valley is such that it should not be eliminated without attempting to provide additional percolation elsewhere. This can only be done between the present Coyote Percolation Ponds and the uppermost point at which percolation can be performed without effecting water levels at Bailey Avenue. It is expected that the return flow now being obtained between Metcalf Road and Malech's Crossing will be eliminated if percolation is discontinued between there and Daly's Crossing. Therefore, those intervals in which low percolation rates are now obtained due to return flow will probably cease to have this limitation and can be utilized far more effectively than is possible under present conditions. It is not unlikely that by increasing the percolation area in the vicinity of the gorge the additional percolation will not only compensate for the loss in Coyote Creek but increase the overall percolation of the system by a significant amount.

No effects are anticipated in the Lower Santa Clara Valley provided the total percolation at or above Coyote Ponds remains unchanged. A more uniform rate of percolation in the Coyote Pond may become possible, as a result of more effective control of the flow entering the Lower Gorge. An increase of the average total percolation would cause a small elevation of ground water levels in the Lower Santa Clara Valley with the maximum effect near the lower end of the Lower Gorge.

CONCLUSIONS

1) Under the present system of percolation in Coyote Creek the section between Daly's Crossing and Metcalf Road absorbs an average of less than 5 CFS and is much less effective than the upper section between Daly's Crossing and the diversion.

2) Suspension of percolation in the lower section of Coyote Creek will effectively lower water levels in the vicinity of Bailey Avenue. Only actual

tests will determine how much of the creek bed will have to be eliminated in order to obtain the desired level of 5 ft below the surface.

3) Water levels in wells between Bailey Avenue and Anderson Reservoir will be depressed by amounts less than 5 ft with only a negligible lowering in the uppermost part of the valley.

4) Increased percolation will be possible in the vicinity of Metcalf Road as a result of the anticipated elimination of effluent conditions in that section of Coyote Creek. Percolation in this area will not interfere with measures taken to lower water levels at Bailey Avenue. No effects are expected below the Coyote percolation ponds if additional percolation near Metcalf Road compensates for that lost in the Coyote Creek bed.

RECOMMENDATIONS

It is recommended that percolation procedures in Coyote Creek be modified as follows:

1) As long as the water level in Well 8 remains less than 5 ft below the surface, only that quantity of water should be allowed to flow down the creek channel which can be effectively absorbed above Daly's Crossing. It is estimated that this will average approximately 15 CFS.

2) The balance of the flow released from Anderson Reservoir can be directed through the diversion channel,

which should be capable of conducting up to 170 CFS if it is concrete lined or enlarged throughout its length.

3) The diversion channel should rejoin Coyote Creek at a point near Lockyear's Crossing. involves approx. 21,000 ft. of Coyote Canal RRE Spreading dams of a temporary type should be installed between this point and the existing Coyote ponds, in order to increase the total percolation in the area of the gorge.

4) Continuous observations should be made at Well 6 and other observation wells above and below Bailey Avenue to determine the effectiveness of these measures. Regulation of the flow past the diversion will be necessary in order to obtain the desired water levels.

TABLE 1 - SUMMARY OF SELECTED PERCOLATION CHECKS, cfs

COYOTE CREEK BED

DATE	ABOVE DALY'S CROSSING	BELOW DALY'S CROSSING	TOTAL
Nov. 1, 1957	6.65	.40	7.05
Nov. 8, 1957	3.75	1.63	5.38
Nov. 13, 1957	3.99	2.85	6.84
Dec. 6, 1957	2.69	3.18	5.87
Dec. 21, 1959	2.31	.95	3.26
Dec. 26, 1957	.71	1.28	1.99
Sept. 5-6, 1958	20.22	9.19	29.41
Oct. 8-10, 1958	15.63	12.98	28.61
Feb. 7, 1959	8.28	2.54	10.82
Mar. 6, 1959	5.80	1.52	7.32
Dec. 16, 1959	11.09	5.67	16.76
AVERAGE	7.47	3.83	11.30
PERCENT	66.1	33.9	100.0

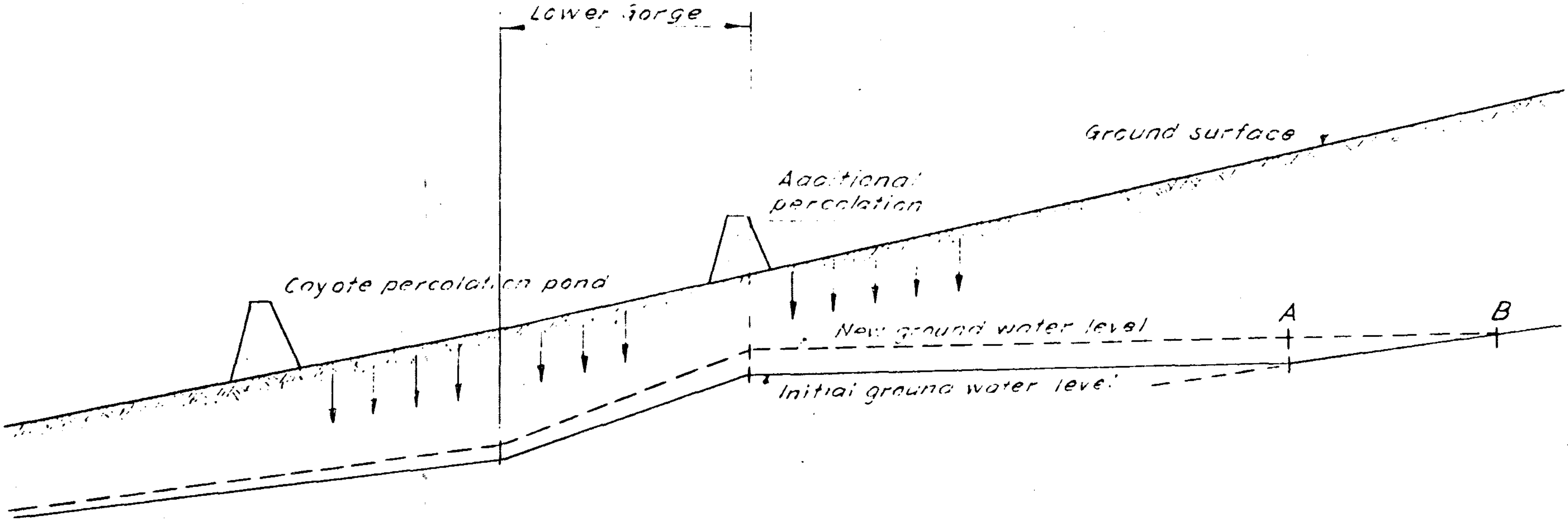

Fig. 5
Schematic diagram of effect of increased percolation near the lower gorge
(not to scale)

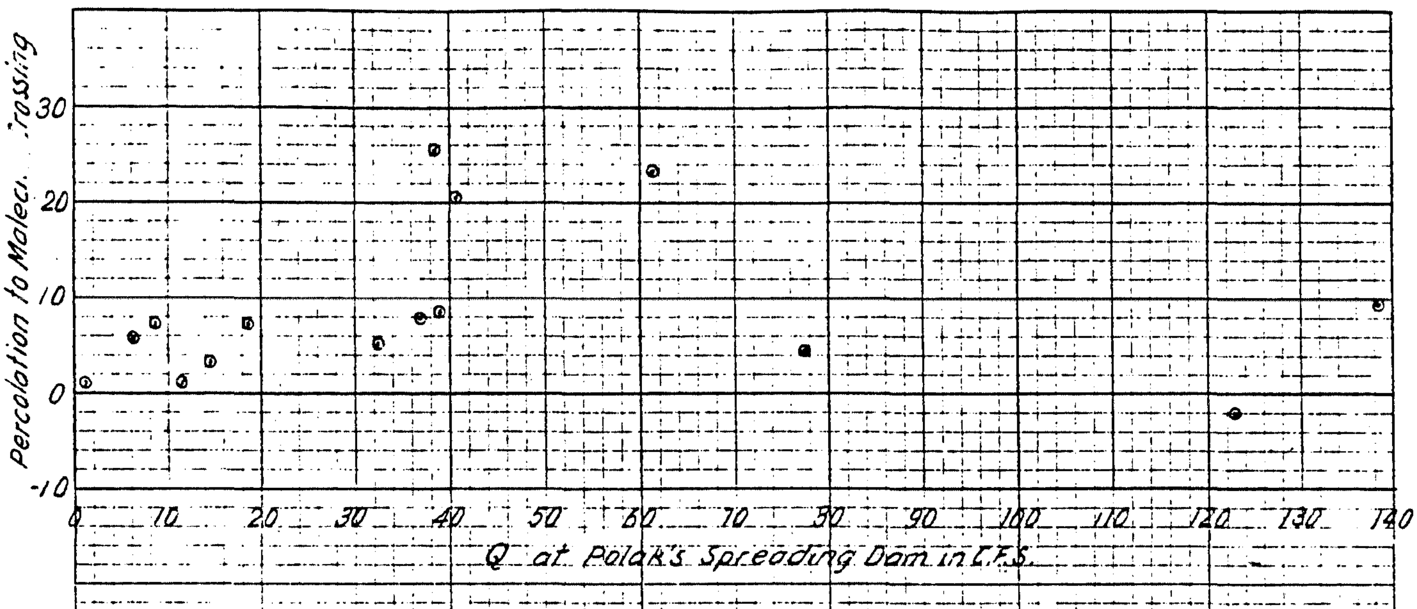

Fig. 3-A
Relation of percolation rates to flow in lower half of Coyote creek

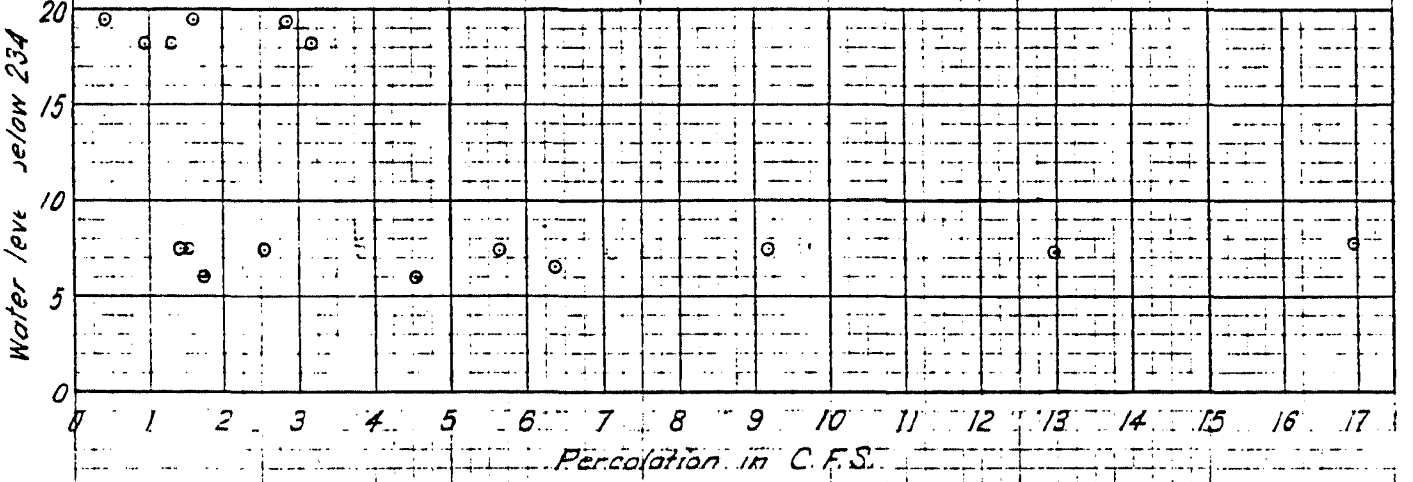

Fig. 3-B
Relation of percolation to ground water levels in lower half of Coyote creek

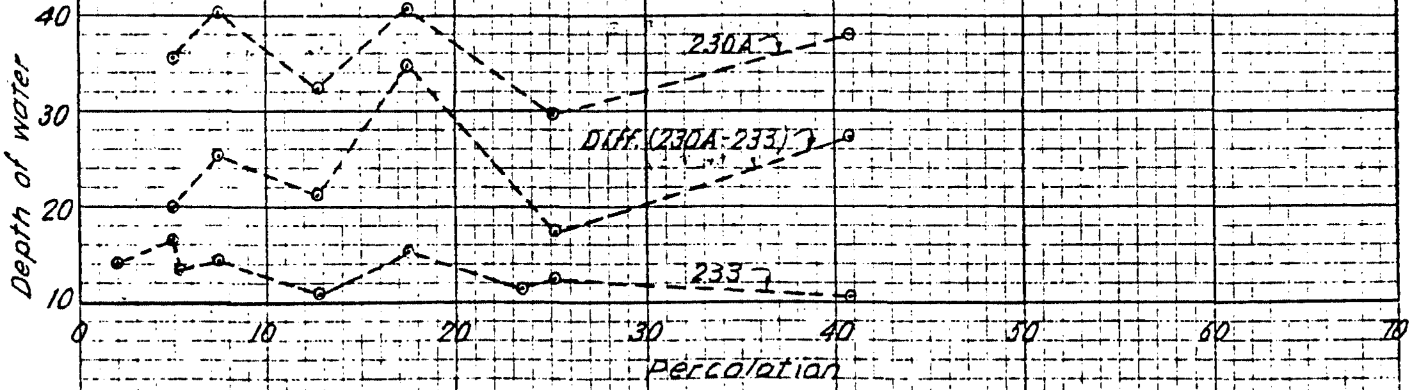

Fig. 3-C
Relation of percolation in the Coyote percolation ponds to ground water levels and gradients

FIGURE 1

GENERALIZED MAP
OF THE UPPER SANTA CLARA VALLEY
SHOWING LOCATION OF PRINCIPAL
FEATURES AND REFERENCE WELLS

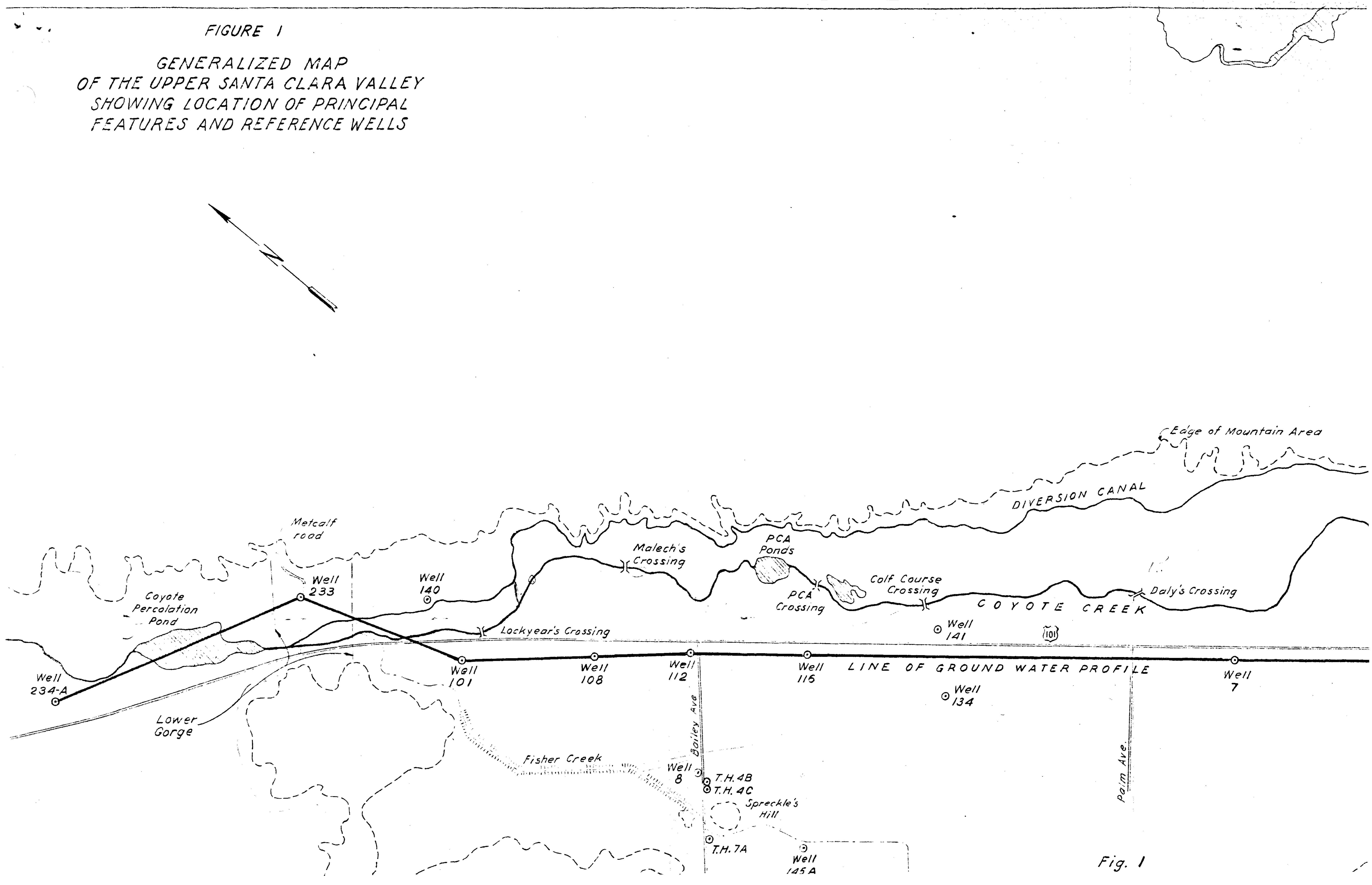

Fig. 1

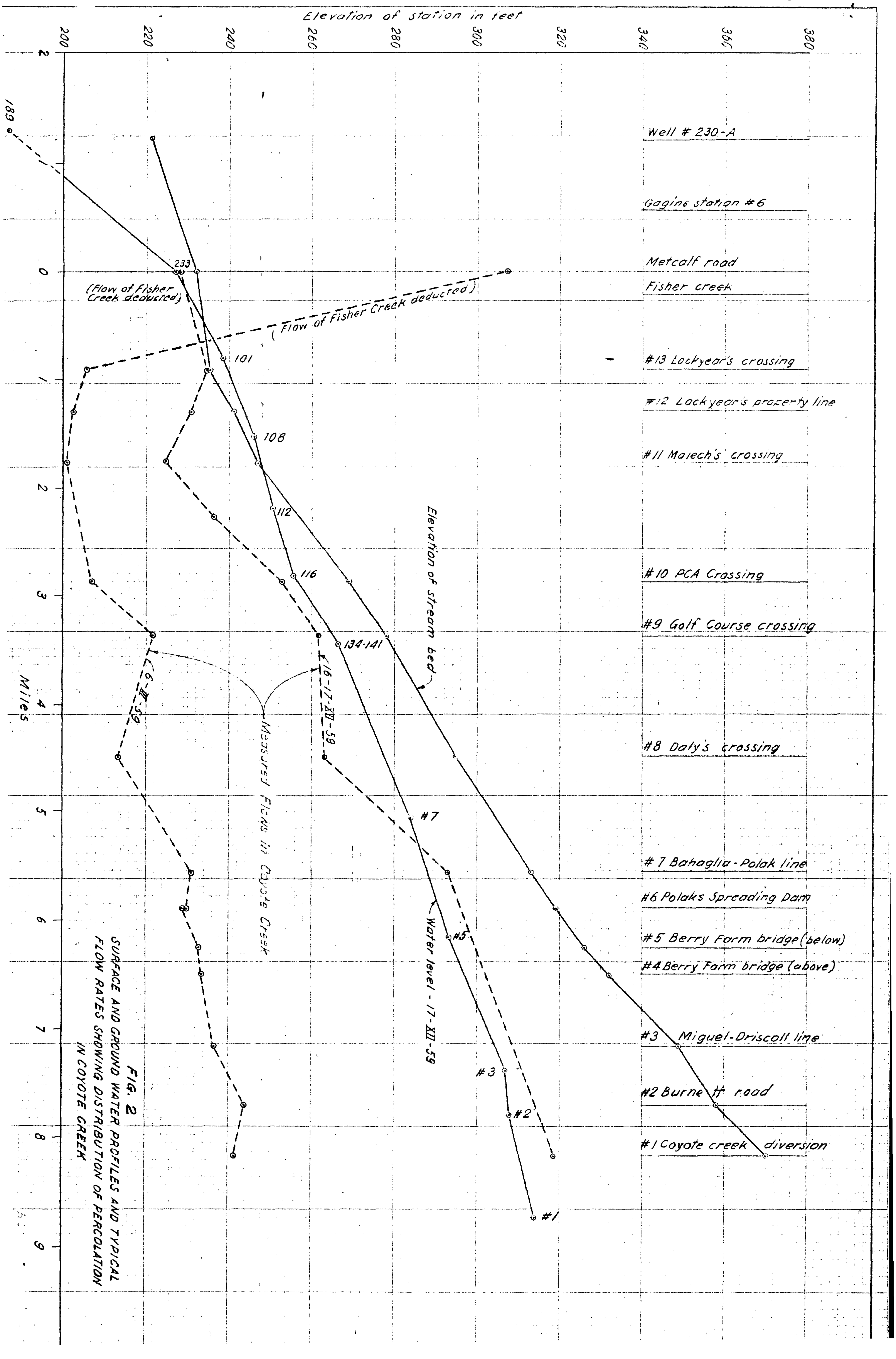

FIG. 2
SURFACE AND GROUND WATER PROFILES AND TYPICAL FLOW RATES SHOWING DISTRIBUTION OF PERCOLATION IN COYOTE CREEK

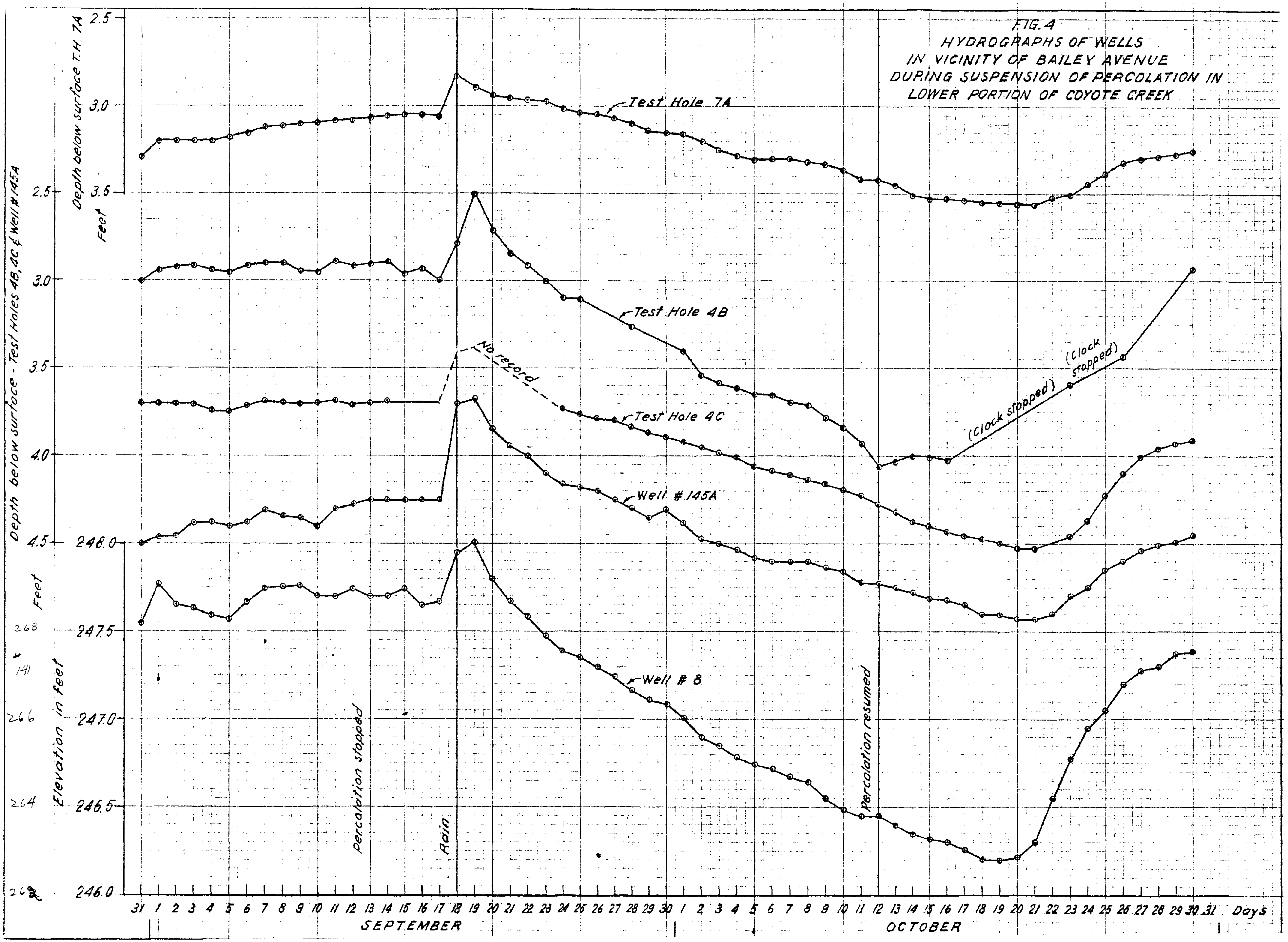

FIG. 4
HYDROGRAPHS OF WELLS
IN VICINITY OF BAILEY AVENUE
DURING SUSPENSION OF PERCOLATION IN
LOWER PORTION OF COYOTE CREEK